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# Anabolic-Androgenic Steroid Use in the Eastern Mediterranean Region: a Scoping Review of Extant Empirical Literature

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## Abstract

The use of image- and performance-enhancing drugs particularly anabolic-androgenic steroids (AAS) is not a new phenomenon. AAS use is not limited to athletes, with mainstream populations using these drugs for aesthetic purposes. Prevalence has been predominantly in Western countries, with some recent studies indicating a rise in popularity in the Eastern Mediterranean region. A scoping review of extant empirical literature from the Eastern Mediterranean region described and mapped what is known about the extent of AAS in the region. Four themes emerged from the review: (1) profile of AAS users; (2) AAS within gymnasium practice; (3) AAS regimes of use; and (4) knowledge and understanding of the AAS concept and related adverse effects. The review highlights a relatively new phenomenon of AAS use in the Eastern Mediterranean. The review underscores the need to carry out further research, particularly qualitative and quantitative studies with both genders, and cognisant of the complexities of culture and religiosity.

**Keywords** Anabolic steroids · Eastern Mediterranean · Gym users · Image- and performance-enhancing drugs

The use of image- and performance-enhancing drugs (IPEDs) particularly anabolic-androgenic steroids (AAS) is not a new phenomenon (Dimeo 2007; Hoberman 2001; Yesalis 2001; Zahnow et al. 2018). Globally, rising numbers of individuals who want to have an improved physique and increased well-being revert to the use of IPEDs (Evans-Brown et al. 2012), and particularly amongst

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gym populations (Kimergard and McVeigh 2014). Anabolic-androgenic steroids are a common IPED and are synthetic derivatives of testosterone, the male sex hormone (Evans 2004; Kicman 2008; McVeigh and Begley 2017; Pope et al. 2014a, 2014b). These substances emulate biological characteristics of these male hormones thus reproducing the effects on the body, resulting in the growth of male sexual characteristics and skeletal muscle (Pope and Kanayama 2012; Sagoe et al. 2014a, 2014b; Sobhanian et al. 2013). They are used medically to treat a number of conditions including protein-calorie malnutrition associated with weight loss, HIV wasting syndrome (Mulligan and Schambelan 2002), and primary and secondary hypogonadism (Behre et al. 1999; Nieschlag 2006; Sarosdy 2007; Taylor 2002). The use of AAS for performance-enhancing purposes amongst athletes has been reported since the 1950s (Hakansson et al. 2012; Hoberman 1992; Kanayama et al. 2008; Kanayama and Pope 2018; Mottram 2018; Yesalis 2000; Zahnow et al. 2018). Currently, the majority of users of AAS are not competing athletes, with patterns of use primarily for aesthetic purposes (Begley et al. 2017; Kimergard and McVeigh 2014; Parkinson and Evans 2006; Pope et al. 2012; Pope et al. 2014a, 2014b; Santos and Coomber 2017). These users focus primarily on their appearance, body weight, muscle build, and leanness as opposed to their athletic performance (Hakansson et al. 2012; Parkinson and Evans 2006; Petersson et al. 2010). In 1999, the World Anti-Doping Agency (WADA) was established to monitor drug use (doping) in sport. The anti-doping code was adopted in 2003 and acts as a framework for sports organisations to enable them to implement rules, regulations, and policies within sport. WADA and the CODE protect athlete's fundamental rights to participate in sport that is doping-free, promotes equality and fairness for athletes worldwide, and ensures effective detection, deterrence, and prevention programs are harmonised worldwide (WADA 2019).

There are numerous adverse health consequences that can result from the use of AAS. Of concern is the long-term morbidity and mortality due to cardiovascular (Baggish et al. 2017) hepatic (Creagh et al. 1988; Schumacher et al. 1999) and cognitive effects (Bjornebekk et al. 2017; Westlye et al. 2017) of AAS use. Other health consequences include those affecting other organ systems such as gynaecomastia, acne, hair loss (Pope et al. 2014a, 2014b), and impaired sexual function (Kanayama and Pope Jr. 2012). Psychological effects of AAS use include mood disturbances (Kanayama and Pope Jr. 2012) and dependence (Pope et al. 2014a, 2014b). Some of these adverse effects are acute but subside once the use of AAS has ceased. Chronic conditions can result from the long-term use of these substances (Pope et al. 2014a, 2014b). Lindqvist et al. (2013) reported an association between the past use of AAS and long-term poorer mental health outcomes. Negative psychological states have also been reported such as depression, increased aggression, and anxiety (Pope et al. 2005) and with the severity of these possibly dependent on AAS dosage (Kimergard and McVeigh 2014).

Traditionally AAS for image and performance enhancement have been taken in 'cycles'. These regimens involve periods of use of the substances that last 6 to 12 weeks, sometimes more (Yesalis 2000). Research has indicated an increased cycle (the period that drugs are used) length whereby users utilise a 'blast and cruise' method. This phenomenon is when the user replaces the 'off-cycle' with a period of lower dosage. This has implications for the recovery of testosterone production and health outcomes (Chandler and McVeigh 2014). Users of AAS regularly consume a range of substances simultaneously known as 'stacking' (Sagoe et al. 2015; Yesalis 2000). The reasons for stacking are an endeavour to achieve synergistic effects which allows the user to stimulate more receptor sites, thus creating greater anabolic effects (Duchaine 1989; Nilsson 2001; Yesalis 2000). Additionally, those who inject AAS, which is the primary route of administration (Bates et al. 2017), are at further risk of harms such as injecting site wounds, injecting errors such as the incident reported in Jordan in 2002, which

was associated with the death of a 22 year old (Boulad 2003), bacterial and fungal infections in the event of sharing injecting equipment, and the transmission of blood borne viruses (ACMD 2010; Bates et al. 2017; Bates and McVeigh 2016). Appropriate harm reduction interventions targeting AAS users are crucial to preventing these adverse outcomes (Glass et al. 2019).

In terms of prevalence of this phenomenon, Sagoe and Pallesen (2018) have suggested that AAS use is generally recorded as more prevalent in Western countries, Brazil and the Middle East, and less widespread in Asia and Africa. Studies carried out in Eastern Mediterranean countries indicate that the use of AAS, whilst low, is on the rise and therefore a growing concern. Hence, we conducted a scoping review of extant empirical literature to describe and map what is known about the relatively new phenomenon of AAS use in the Eastern Mediterranean.

## Methods

Scoping reviews are increasingly utilised as independent research methodologies to address broader research questions in comparison to systematic reviews (Arksey and O'Malley 2005; Khalil et al. 2016; Levac et al. 2010; Peters et al. 2015). They are usually conducted to identify gaps in knowledge, examine the extent (i.e. size), range (i.e. variety), and nature (i.e. characteristics) of the evidence on a certain topic or question (in this case, AAS use in the Eastern Mediterranean), summarise findings from a heterogeneous body of knowledge, or set agendas for future research and policy directives (Arksey and O'Malley 2005; Brandt et al. 2014; Daudt et al. 2013; Levac et al. 2010; Tricco et al. 2016). Scoping reviews are defined by Tricco et al. (2016) as 'a type of knowledge synthesis, follow a systematic approach to map evidence on a topic and identify main concepts, theories, sources, and knowledge gaps.'

We adhered to Arksey and O'Malley's (2005) five stage iterative process scoping review methodology. These stages included the following: (1) identifying the essential research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collecting, summarising, and reporting the results. The process was underpinned by the research question (*What do we know about AAS use in the Eastern Mediterranean region?*) and reviewed all available published empirical literature in the English language on this topic. There was no restriction on date. To enable the broadest picture of current knowledge and perceptions relating to this issue, we included policy documents and international and national reports, online reports, conference proceedings, commentary pieces, and editorials, in addition to articles in scholarly peer reviewed journals. The search was implemented in April 2019. We used the following databases: Web of Science; Cochrane Library; MEDLINE; PsycINFO; SPORTDiscus; Social Science Citation Index; Conf Proceedings Citation index; PubMed; Science Direct; and Researchgate. A thorough list of key search terms used in AAS research articles known to the research team (who had public health, addiction, and clinical specialisms) informed the search strategy (see Table 1).

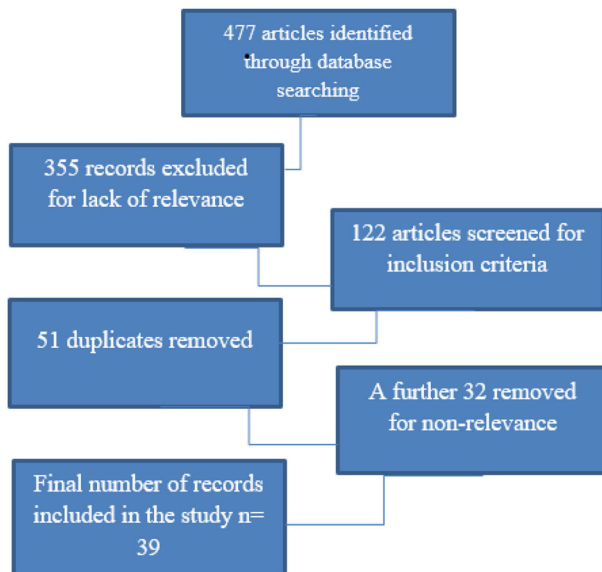
Eligibility criteria focused on use of AAS in Eastern Mediterranean Countries, i.e. Afghanistan, Bahrain, Djibouti, Egypt, Iran (Islamic Republic of), Iraq, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates, and Yemen (WHO, 2019). Inclusion and exclusion criteria were discussed and agreed with all members of the research team. Clinical case reports, case series, and laboratory analysis only studies were excluded. The

**Table 1** Search terms

Key word	Alternative
Anabolic Androgenic Steroids	anabolic steroids OR anabolic-androgenic OR anabolic hormones OR performance enhancing OR doping OR image enhancing OR IPED OR PIED OR PED OR PEA
Muscle	sport OR athletes OR muscle OR gym OR fitness OR bodybuild OR weight lift OR physique OR gymnasium OR commercial club
Middle Eastern Countries	Middle East OR Eastern Mediterranean OR Arab OR Afghanistan OR Bahrain OR Djibouti OR Egypt OR Iran OR Iraq OR Jordan OR Kuwait OR Lebanon OR Libya OR Morocco OR Oman OR Pakistan OR Qatar OR Saudi Arabia OR Somalia OR Sudan OR Syria OR Tunisia OR United Arab Emirates OR Yemen

initial search identified 477 articles; and following initial screening, 355 were removed for lack of relevance, with the remaining 122 screened for inclusion in the study. Finally, duplicates ( $n = 51$ ) and further records excluded for lack of relevance were removed ( $n = 32$ ), leaving 39 records in total (see Fig. 1).

The 39 records were charted and thematically analysed, as per Arksey and O'Malley (2005). A table was created using Microsoft Word to chart relevant data (year of publication, author, location, method and aim, key findings, and conclusion) and to analyse the extracted data thematically to identify commonalities, emergent issues, and gaps in the literature. A trial charting exercise of several records was conducted by the lead author as recommended by Daudt et al. (2013). This was followed by a team consultation to ensure consistency with the research question and the scoping review aim, and to identify prior categories to support further data extraction and charting. The textual dataset was re-read numerous times by author one to gain familiarity with the data and identify and code emerging themes. The charted data was analysed and systematised by thematic manual coding, which organised the data and subsequently structured into themes through patterns identified in associated categories (Crossley

**Fig. 1** Flow chart of the search strategy used

2007). Following data analysis, two papers were omitted (Boos et al. 2011; Cassler et al. 2013) as their results showed that  $n = 0$  AAS users were found in their studies, leaving a final number of 37 included studies in the review (see Fig. 2). Four themes emerged from the review: (1) profile of AAS users; (2) AAS within gymnasium practice; (3) AAS regimes of use; and (4) knowledge and understanding of the AAS concept and related adverse effects.

## Results

We included published empirical records on AAS from searches in the twenty-one countries located in the Eastern Mediterranean region. The types of records included were *survey studies* in Saudi Arabia (Al Bishi and Afify 2017; Al Ghobain et al. 2016; Al Nozha and Elshatarat 2017; Alharbi et al. 2019; Althobiti et al. 2018; Bahri et al. 2017; Jabari et al. 2016), United Arab Emirates (Al-Falasi et al. 2008), Kuwait (Allafi et al. 2019; Alsaeed and Alabkal 2015; Khullar et al. 2016), Iran (Allahverdipour et al. 2012; Angoorani and Halabchi 2015; Asr et al. 2018; Bordbar et al. 2014; Fijan et al. 2018; Haerinejad et al. 2016; Jalilian et al. 2011; Kargarfard et al. 2015; Mohammad 2014; Nakhaee et al. 2013; Razavi et al. 2014; Rezaei 2017; Saeidinejat et al. 2017; Sepehri et al. 2009; Sobhanian et al. 2013), Iraq (Boos et al. 2010; Habeeb et al. 2012), Lebanon (Hitti et al. 2014; Melki et al. 2015), Jordan (Tahtamouni et al. 2008; Wazaify et al. 2014), Pakistan (Hussain et al. 2018; Uddin et al. 2019; Zafar et al. 2018), and Sudan (Khidir and Mahmoud 2018); and *conference proceedings* from Bahrain (Alsamani et al. 2017) (see Table 2).

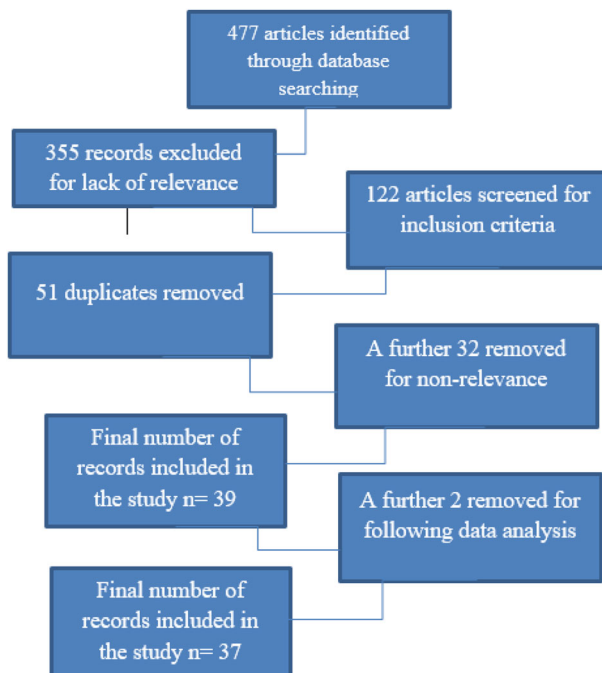


Fig. 2 Updated flow chart following data analysis

**Table 2** Two 'Study characteristics'

Included studies						
Author, year	Study years	Country	AAS users m/f	Aims	Methods	Results and conclusion
Al Bishi and Afify <a href="#">2017</a>	2016	Saudi Arabia	89 m	Estimate AAS prevalence. Determine awareness off AAS adverse effects amongst users.	Cross-sectional survey. Questionnaires ( <i>n</i> = 363) at fitness centres.	High prevalence of AAS use; inadequate awareness of adverse effects; main source for AAS were online methods; testosterone most commonly used AAS; both oral and injectable forms used. Recommended educational programs; tightening of controls of sources of AAS.
Al-Falasi et al. <a href="#">2008</a>	2006	United Arab Emirates	34 m	Estimate AAS prevalence. Determine awareness off AAS adverse effects amongst users.	Cross-sectional survey. Questionnaires ( <i>n</i> = 154) at gymnasiums.	High prevalence of AAS use; AAS use higher amongst nationals, bodybuilders, weightlifters, and commercial club users; 7% of non-users intended to use AAS in the future; ROA not reported; main source for AAS were fitness stores. Recommended programs to increase awareness.
Al Ghobain et al. <a href="#">2016</a>	2015	Saudi Arabia	50 m	Estimate lifetime prevalence of doping. Address knowledge and attitudes of doping.	Cross-sectional survey. Questionnaires ( <i>n</i> = 1142) sport clubs, stadiums, and sports fields.	Prevalence of doping in Saudi Arabia is reportedly 4.3%. ROA and sourcing not reported; Improve performance reason to use AAS; doping was associated with low primary education. Recommend advances in 'doping' screening.
Alharbi et al. <a href="#">2019</a>	2016	Saudi Arabia	134 m	Assess knowledge and practices of AAS users.	Cross-sectional survey. Questionnaires ( <i>n</i> = 482) at gymnasiums.	Limited awareness of AAS adverse effects. ROA not reported; main source for AAS were gym coaches. Recommended public education & health policy reform.
Allafi et al., <a href="#">2019</a>	Not stated	Kuwait	43 m	Estimate AAS prevalence. Examine AAS users' characteristics. Examine association between AAS users and self-reported side effects.	Cross-sectional survey. Questionnaires ( <i>n</i> = 150) at gymnasiums.	High prevalence of AAS use; testosterone and Deca-Durabolin most commonly used; both oral and injectable forms used; pharmacies were main source for AAS. Recommended educational initiatives for youths.
Allahverdiপুর et al. <a href="#">2012</a>	2008–2009	Iran	62 m		Correlational study.	The study confirmed the applicability of the TPB to explain AAS use of gym users. ROA not reported;

**Table 2** (continued)

Included studies						
Author, year	Study years	Country	AAS users m/f	Aims	Methods	Results and conclusion
Al Nozha and Elshatarat 2017	2016	Saudi	222 m	To explore gym users' intentions to us AAS based on the theory of planned behaviour (TPB).	Questionnaires ( <i>n</i> = 253) at gymnasiums.	testosterone and Anadrol most used AAS. Recommended using TPB to design prevention programs for adolescents; and to help athletes reach goals without AAS.
				Assess user's knowledge, attitudes and beliefs about adverse effects of AAS.	Cross-sectional survey. Questionnaires ( <i>n</i> = 316) at gymnasiums.	Widespread misuse of PEAAs in gyms in Saudi Arabia. ROA not reported; testosterone most used AAS.
				Assess link between these factors and participants use of AAS.		Recommended improving knowledge and awareness of AAS effects via health education; further research to examine intervention effectiveness.
				Assess gym user's knowledge, attitudes and AAS practice.	Cross-sectional study. Questionnaires ( <i>n</i> = 194) at fitness centres.	Significant differences between AAS users and non-users beliefs and attitudes to adverse effects of AAS. Peer effect is a factor in misuse of AAS. Both oral and injectable ROA; main source for AAS is gym trainers.
Althobiti et al. 2018	2017	Kuwait	474 m	Assess gym user's knowledge, attitudes and AAS practice.	Cross-sectional survey. Questionnaires ( <i>n</i> = 4860) at gymnasiums.	All users had inadequate knowledge of AAS adverse effects; both oral and injectable ROA; testosterone most commonly used AAS, then Dianabol; main source for AAS is gym trainer.
Angoorani and Halabchi 2015.	2011	Iran	150 m	Determine prevalence of AAS abuse.	Survey via interview using structured questionnaires ( <i>n</i> = 906) at gymnasiums.	High prevalence of AAS use in Tehran; most used AAS nandrolone decanoate; ROA not reported; psycho-socio- demographic factors associated with AAS abuse. Recommended recognising predisposing factors to AAS use for use implementing education and prevention programs.
Asr et al. 2018.	2016	Iran	76 m	Examine demographics and psychosocial factors of AAS use amongst bodybuilders	Cross-sectional study. Questionnaires ( <i>n</i> = 280) at gymnasiums.	Significant links between AAS use and attitudes, self-efficacy and AAS use of trainers and friends; ROA not reported; combined AAS most commonly used followed by testosterone.



**Table 2** (continued)

Included studies					Results and conclusion
Author, year	Study years	Country	AAS users m/f	Aims	
Bahri et al. 2017.	Not stated	Saudi Arabia	144 m	Examine AAS prevalence.	Recommended educational interventions based on social and individual factors. High prevalence of AAS use; Deca-Durabolin and testosterone most commonly used AAS; both oral and injecting practices reported. Recommended increased awareness on adverse effects of AAS use.
Boos et al. 2010	Not stated.	Iraq.	14 m	Establish AAS and dietary supplements	High prevalence of AAS use; Deca-Durabolin and testosterone most commonly used AAS; both oral and injecting practices reported. Recommended increased awareness on adverse effects of AAS use.
Bordbar et al. 2014	2008	Iran	11 m	Determine the frequency of and attitudes to AAS use amongst athletic medical students.	Low prevalence of AAS use; AAS used on ROA not reported; sourcing reportedly on military base. Recommended greater awareness and more education re risks of AAS use and health-related effects. High AAS use amongst bodybuilders; AAS use suggested by gym trainers; ROA and sourcing not reported
Fijan et al. 2018.	Not stated	Iran	96 m	Determine prevalence and characteristics of AAS use.	Recommended further research e.g. longitudinal studies.
Habeeb et al. 2012.	Not stated	Iraq	95 m	Identify perceptions of substance use of bodybuilders and athletes.	Most participants began using dietary supplements only; influenced to use AAS by coach, friend, physician; both oral, injecting and a combination of both ROA reported; Sourcing and type of AAS used not reported. Recommended further studies to determine health-related adverse effects of AAS use.

**Table 2** (continued)

Included studies						
Author, year	Study years	Country	AAS users m/f	Aims	Methods	Results and conclusion
Haerinejad et al. 2016	2015	Iran	234 m	Investigate prevalence and characteristics of IPED us in bodybuilders.	Survey study. Questionnaires ( <i>n</i> = 453) at gymnasiums.	79.4% of athletes abused AAS; primary reason for use was to increase muscle mass; sourcing was via trainers, friends, gym partners, and pharmacies; adverse effects most reported were sexual and dermatologic; ROA was not reported. Recommended evaluation AAS use in cycling and wrestling.
Hitti et al. 2014	Not stated.	Lebanon	55 m	Assess prevalence and determinants AAS use.	Cross-sectional study. Questionnaires ( <i>n</i> = 523) at fitness centres.	Majority of AAS users aware of adverse effects; primary reason to use was to enhance body image; both oral and injecting ROAs; Deca most commonly used AAS; sourcing was not reported. Recommended monitoring AAS use in health clubs: educational programs for high-risk groups.
Hussain et al. 2018	Not stated	Pakistan	60 m	To understand levels of anger/amongst AAS using athletes.	Cross-sectional study. Questionnaires ( <i>n</i> = 120).	AAS users showed higher anger levels than non-users; both oral and injecting ROA reported; testosterone most commonly used AAS; sourcing was via friends and trainers. Recommended further research into the effects of AAS on mental health.
Jabari et al. 2016.	2015	Saudi Arabia	183 m	Determine prevalence of AAS use and user knowledge of AAS effects.	Cross-sectional Study. Questionnaires ( <i>n</i> = 600) at gymnasiums.	High prevalence of AAS use; inadequate knowledge and awareness of harmful effects; ROA and sourcing not reported. Recommended educating athletes on harmful effects; legalising AAS to allow monitoring and control of the substances.
Jalilian et al. 2011	2008–2009	Iran	69 m	Evaluate AAS prevention intervention effectiveness.	Randomised pre-test–post-test series control group design panel study.	All participants used testosterone primarily; sourcing and ROA was not reported; study found that prevention intervention is effective in reducing AAS use.

**Table 2** (continued)

Included studies						
Author, year	Study years	Country	AAS users m/f	Aims	Methods	Results and conclusion
Kargarfard et al. <a href="#">2015</a>	Not stated	Iran	924 m	Measure prevalence and attitudes towards AAS use.	Questionnaires ( <i>n</i> = 1008) at Universities.	Recommended further studies to include females. High prevalence of AAS use; Most commonly used AAS was methane; ROA and sourcing not reported. Recommended population specific AAS intervention programs.
Khullar et al. <a href="#">2016</a> .	Not stated	Kuwait	69 m, 1 f	Determine lifetime prevalence of AAS use.	Questionnaires ( <i>n</i> = 200) at gymnasiums.	Lifetime prevalence of AAS use is high; sourcing not reported; both oral and injectable forms of AAS used. Recommended health policy and institutional reforms help diminish rising AAS use; treat AAS as illicit substances and as a public health concern; public health campaigns; and increased education re harms.
Khidir and Mahmoud <a href="#">2018</a> .	2012–2013.	Sudan	3 m	Examine athlete’s knowledge of doping in sport.	Cross-sectional study. Questionnaires ( <i>n</i> = 60) amongst athletes.	Low prevalence of AAS use; most were aware of banned substances in sport; majority unaware of doping tests; ROA, sourcing and most used AAS not reported. Recommended education at earlier stages in school; education for coaches and trainers.
Melki et al. <a href="#">2015</a> .	2010–2011	Lebanon	518 m	Examine links between AAS use and sociocultural factors such as media and male muscularity.	Cross-sectional survey. Questionnaires ( <i>n</i> = 523) at fitness centres.	Study describes AAS uses as a significant public health issue; majority had awareness of adverse effects; AAS users consume extreme amounts of media and TV related to muscularity; ROA and sourcing of AAS not reported.
Mohammad <a href="#">2014</a> .	2007	Kuwait	202 m	Determine AAS use prevalence and user attitudes of their use.	Questionnaires ( <i>n</i> = 1708) at sports clubs.	Inadequate knowledge of adverse effects; lack of public awareness of effects; 59% believed benefits of AAS use outweighed risks; encouraged to use AAS by coaches and friends; oral ROA only reported; sourcing not reported. Recommended national campaign to advise short- and long-term adverse

**Table 2** (continued)

Included studies						
Author, year	Study years	Country	AAS users m/f	Aims	Methods	Results and conclusion
Nakhaee et al. 2013.	2013	Iran	73 m	Examine prevalence of drug use, particularly anabolic steroids amongst bodybuilders.	Cross-sectional study. Questionnaires ( <i>n</i> = 298) at gymnasiums.	effects; prevention interventions with youths; further research on socioeconomic and behavioural determinants of AAS use. High prevalence of drug use including AAS amongst bodybuilders; ROA and sourcing were not reported; AAS use recommended by peers and coaches.
Razavi et al. 2014.	2011	Iran	72 m	Determine prevalence and patterns of AAS use by bodybuilders.	Cross-sectional study. Questionnaires ( <i>n</i> = 250) at gymnasiums	High frequency of AAS use; AAS use suggested by peers and coaches; testosterone most commonly used; both oral and injecting ROA reported; sourcing was not reported. Recommended further research into underlying reasons to use; implement effective prevention measures amongst youths.
Rezaei 2017	2012	Iran	87 m, 5 f	Determine prevalence of AAS use.	Questionnaires ( <i>n</i> = 214) at gymnasiums	High prevalence of AAS use; many had little to no awareness of adverse effects; both oral and injecting ROAs reported; sourcing was not reported; testosterone most commonly used AAS. Recommended further studies and interventions for youths and athletes.
Saeidinejant et al. 2017.	2015	Iran	311 m	Evaluate prevalence of AAS use.	Descriptive-analytical Cross-sectional study. Questionnaires ( <i>n</i> = 920) at gymnasiums.	Low awareness of knowledge of adverse effects; most commonly used AAS dianabol, testosterone and oxynandrolone; ROA and sourcing not reported. Recommended education for adolescents and youths at high schools, universities and sports clubs; assessing coaches also regarding AAS use; enforcing law.
Sepehri et al. 2009	Not stated	Iran	164 m	Determine types of AAS used and frequency of AAS use in bodybuilders.	Cross-sectional survey. Questionnaires ( <i>n</i> = 202) at gymnasiums.	Most commonly used AAS oxymetholone; sourcing primarily 'black market', and pharmacy; Reasons to use AAS reportedly due to advice from friends and

**Table 2** (continued)

Included studies						
Author, year	Study years	Country	AAS users m/f	Aims	Methods	Results and conclusion
Sobhanian et al. 2013	2012	Iran	154 m	Evaluate prevalence of AAS in bodybuilders.	Cross-sectional study. Questionnaires ( <i>n</i> = 299) at gymnasiums.	coaches; ROA not reported. Recommended educational programs for athletes regarding the adverse effects of AAS use; healthcare systems should also provide information to bodybuilders and athletes. High prevalence of AAS use in study (51.5%); testosterone most commonly used; both oral and injecting ROA reported; sourcing primarily from coaches and supplement suppliers.
Tahtamouni et al. 2008.	Not stated.	Jordan	61 m	Measure extent of AAS abuse amongst students and bodybuilders.	Questionnaire ( <i>n</i> = 657) of university students and bodybuilders.	Financial status was found to be main risk factor for AAS abuse; one third began using before aged 15 years; Deca-Durabolin most commonly used AAS; friends and trainers are primary sources of AAS; ROA not reported. Recommended educational organisations conduct further surveys to measure AAS prevalence; new interventions for users.
Uddin et al. 2019	Not stated.	Pakistan	502 m	Investigate prevalence, knowledge, attitudes, and practices of AAS use.	Cross-sectional study. Questionnaires ( <i>n</i> = 841)	More than half participants reported AAS use; friends and online were main sources; ROA and AAS most used not reported; aggression, mood swings, heart problems and infertility reported. Recommended sport and health policy-makers highlight AAS adverse effects; regulation of markets/sources of AAS.
Wazaify et al. 2014	2012–2013	Jordan	31 n/s	Investigate abuse of OTC and prescription products in gymnasiums.	Cross-sectional survey. Questionnaires ( <i>n</i> = 353)	More than a quarter had never heard of AAS; injecting primary ROA; testosterone most commonly used AAS; sourcing was not reported. Adverse effects reported by AAS users included tachycardia, palpitations, hypertension, priapism, testicular

**Table 2** (continued)

Included studies						
Author, year	Study years	Country	AAS users m/f	Aims	Methods	Results and conclusion
Zafar et al. 2018	Not stated.	Pakistan	98 m	Evaluate AAS use in gyms.	Survey questionnaires ( <i>n</i> = 630)	atrophy, renal, and psychological problems. Recommended enforcing of WADA regulations by MOH inspectors at pharmacies; raise more awareness amongst younger people and coaches. Further qualitative research.
						46% reported AAS current/former use; most common ROA was injecting; sourcing and most commonly used AAS not reported.
Conference Proceedings Alsamani et al. 2017	Not stated.	Bahrain	16 m	Investigate prevalence, knowledge, attitudes and practices of AAS.	Questionnaire ( <i>n</i> = 103) at gymnasiums.	Awareness of adverse effects was high despite continued use; ROA and sourcing were not reported.

## Profile of AAS Users in the Middle East

The quantitative studies from Iran ( $n = 14$ ), Saudi Arabia ( $n = 7$ ), Kuwait ( $n = 4$ ), Lebanon ( $n = 2$ ), United Arab Emirates ( $n = 1$ ), Iraq ( $n = 2$ ), Jordan ( $n = 2$ ), Pakistan ( $n = 3$ ), Sudan ( $n = 1$ ), and conference proceedings from Bahrain ( $n = 1$ ) generated a total of 5425 current and former AAS users. A total of 5371 of these were male and only 6 were female. Three studies did not detail whether the AAS users were male or female (Boos et al. 2010; Khidir and Mahmoud 2018; Wazaify et al. 2014) although female participants were included in their studies. The age range of AAS users ranged from 14 to 60 years old (Al-Falasi et al. 2008; Al Ghobain et al. 2016; Alharbi et al. 2019; Allahverdipour et al. 2012; Al Nozh & Elshatarat, 2017; Alsaeed and Alabkal 2015; Althobiti et al. 2018; Angoorani and Halabchi 2015; Asr et al. 2018; Bahri et al. 2017; Boos et al. 2010; Jabari et al. 2016; Khullar et al. 2016; Bordbar et al. 2014; Fijan et al. 2018; Habeeb et al. 2012; Haerinejad et al. 2016; Hitti et al. 2014; Hussain et al. 2018; Jalilian et al. 2011; Kargarfard et al. 2015; Khidir and Mahmoud 2018; Melki et al. 2015; Mohammad 2014; Razavi et al. 2014; Tahtamouni et al. 2008; Uddin et al. 2019; Wazaify et al. 2014; Zafar et al. 2018). Seven studies did not clearly state age or age range (Allafi et al. 2019; Alsamani et al. 2017; Nakhaee et al. 2013; Rezaie, 2017; Saeidinejat et al. 2017; Sepehri et al. 2009; Sobhanian et al. 2013). Participants were from Iran, Saudi Arabia, United Arab Emirates, Kuwait, Lebanon, Jordan, Iraq, Bahrain, Pakistan, and Sudan, with no notable differences in age ranges between countries. Those aged 18–34 years reported using AAS to a greater extent than other age groups (14–17 and 35–59 years). Not all studies reported on background characteristics such as marital status, employment status, and education. Studies that did report on demographics are presented in Table 3.

## Gymnasium Practice in the Eastern Mediterranean Region

Gymnasium practice was not reported by twenty-one peer reviewed journal papers (Al Ghobain et al. 2016; Allafi et al. 2019; Al Nozha and Elshatarat 2017; Alsaeed and Alabkal 2015; Alsamani et al. 2017; Althobiti et al. 2018; Asr et al. 2018; Boos et al. 2010, 2011; Bordbar et al. 2014; Haerinejad et al. 2016; Hitti et al. 2014; Jabari et al. 2016; Kargarfard et al. 2015; Khullar et al. 2016; Khidir and Mahmoud 2018; Melki et al. 2015; Mohammad 2014; Nakhaee et al. 2013; Saeidinejat et al. 2017; Sobhanian et al. 2013; Tahtamouni et al. 2008). The types of gyms and fitness clubs where AAS were used included gymnastics clubs (Saudi Arabia), commercial gyms and social clubs (Saudi Arabia, United Arab Emirates, Iraq, Iran, Pakistan), hotel gyms (United Arab Emirates), private clubs (Saudi Arabia), bodybuilding clubs (Iran, Saudi Arabia, Kuwait), sports centres (Pakistan), martial arts clubs (Saudi Arabia), rec centres (Pakistan), and athletic clubs (Iran) (Al Bishi and Afify 2017; Al-Falasi et al. 2008; Alharbi et al. 2019; Alsamani et al. 2017; Angoorani and Halabchi 2015; Bahri et al. 2017; Fijan et al. 2018; Habeeb et al. 2012; Haerinejad et al. 2016; Hussain et al. 2018; Jalilian et al. 2011; Kargarfard et al. 2015; Mohammad 2014; Nakhaee et al. 2013; Razavi et al. 2014; Rezaei 2017; Sepehri et al. 2009; Sobhanian et al. 2013; Tahtamouni et al. 2008; Uddin et al. 2019; Zafar et al. 2018). The remaining fifteen papers did not state the type of settings they recruited participants from.

Users reported using gymnasias for less than 6 months ( $n = 31$ ), more than 6 months ( $n = 165$ ), more than 2 years ( $n = 107$ ), more than 4 years ( $n = 54$ ) and one paper reported 11 months

**Table 3** Background characteristics

Characteristics	Country	<i>n</i>	%
Marital status			
Married	Saudi Arabia	235	41.16
	UAE	16	48.48
	Iran	164	21.24
	Lebanon	67	11.71
	Kuwait	12	5.94
Single	Saudi Arabia	322	56.39
	UAE	17	51.52
	Iran	608	78.76
	Lebanon	499	87.24
	Kuwait	190	94.06
Divorced	Saudi Arabia	14	2.45
	Lebanon	6	1.05
Level of education			
Basic education	Saudi Arabia	46	6.11
	Kuwait	12	5.02
Higher education	Saudi Arabia	492	65.34
	Kuwait	123	51.46
	UAE	7	20.59
	Iran	606	61.77
	Lebanon	438	76.98
	Bahrain	70	67.96
Secondary school	Saudi Arabia	204	27.09
	Kuwait	64	26.78
	UAE	20	58.82
	Iran	42	4.28
	Lebanon	56	9.84
Primary School	Saudi Arabia	11	1.46
	Kuwait	40	16.74
	UAE	7	20.59
	Iran	333	33.94
	Lebanon	30	5.27
	Bahrain	33	32.04
Technical	Lebanon	45	7.91
Employment status			
Employed	Saudi Arabia	427	62.06
	UAE	25	73.53
	Iran	9	15.00
	Lebanon	376	64.72
	Iraq	14	1.4
	Jordan	2	100.00
Unemployed	Saudi Arabia	25	3.63
	UAE	1	2.94
	Iran	51	85.00
	Lebanon	196	33.73
Student	Saudi Arabia	236	34.30
	UAE	8	23.53
	Lebanon	9	1.55

to 10 years (Jalilian et al. 2011). Users spent between two and five days ( $n = 75$ ), more than three days ( $n = 18$ ), and more than five days ( $n = 72$ ) per week at their chosen gymnasium. Reasons for attending a gymnasium included bodybuilding, muscle building, professional training and daily gym practice (Al Bishi and Afify 2017; Al-Falasi et al. 2008; Alharbi et al. 2019; Althobiti et al. 2018).



## AAS Regimes of Use in the Eastern Mediterranean Region

Sourcing of AAS was not investigated by more than half of the included studies (Al Ghobain et al. 2016; Allahverdipour et al. 2012; Al Nozha and Elshatarat 2017; Alsamani et al. 2017; Angoorani and Halabchi 2015; Asr et al. 2018; Bahri et al. 2017; Bordbar et al. 2014; Fijan et al. 2018; Jabari et al. 2016; Jalilian et al. 2011; Karfargard et al., 2015; Khullar et al. 2016; Khidir and Mahmoud 2018; Melki et al. 2015; Mohammad 2014; Razavi et al. 2014; Rezaie, 2017; Saeidinejat et al. 2017; Zafar et al. 2018). However, research conducted in Saudi Arabia, United Arab Emirates, Kuwait, Iran, Iraq, Lebanon, Pakistan, and Jordan did report sourcing. Purchasing from friends, gym trainers, and coaches were the primary sourcing routes in these countries. Other sourcing routes included sourcing via gym members, training partners, the black market, online purchasing, pharmacists, physicians, veterinary surgeons, fitness stores, and purchasing abroad and bringing home. One military based study reported sourcing on site (Boos et al. 2010), i.e. the Contingency Operating Base and the PX retail store on base.

A range of AAS and other IPEDs were reported as being used. Sixteen studies (Al Bishi and Afify 2017; Allafi et al. 2019; Allahverdipour et al. 2012; Al Nozha and Elshatarat 2017; Alsaeed and Alabkal 2015; Althobiti et al. 2018; Angoorani and Halabchi 2015; Asr et al. 2018; Bahri et al. 2017; Hitti et al. 2014; Hussain et al. 2018; Jalilian et al. 2011; Kargarfard et al. 2015; Mohammad 2014; Razavi et al. 2014; Wazaify et al. 2014) reported on the types of AAS and associated drugs being used. The most commonly reported injectable were testosterone and nandrolone decanoate, and the most common oral AAS used were methandrostenolone and stanozolol, with the use of growth hormone reported in only four studies. Routes of administration (ROA) were reported in less than half of the studies (Al Bishi and Afify 2017; Allafi et al. 2019; Alsaeed and Alabkal 2015; Bahri et al. 2017; Habeeb et al. 2012; Hitti et al. 2014; Hussain et al. 2018; Khullar et al. 2016; Razavi et al. 2014; Wazaify et al. 2014; Zafar et al. 2018) highlighting injecting as the predominant choice of ROA amongst users. Sobhanian et al. (2013) did not elaborate on the predominant route but reported both oral and injecting routes of administration. Their research also interestingly gave detailed information regarding the person administering the injection of AAS to the user (other than self) which included coach ( $n=9$ ); coach, teammate, or nurse ( $n=1$ ); coach or friend ( $n=1$ ); coach or nurse ( $n=1$ ); coach or physician ( $n=1$ ); physician ( $n=4$ ); teammate ( $n=6$ ); teammate or nurse ( $n=1$ ); friend ( $n=4$ ); family member ( $n=1$ ); another athlete ( $n=8$ ).

Duration of AAS use was only reported in a small number of articles (Al Bishi and Afify 2017; Alsamani et al. 2017; Asr et al. 2018; Bahri et al. 2017; Sobhanian et al. 2013) and ranged from less than 1 month to more than 5 years. One study in Saudi Arabia reported that 69.7% of AAS user participants simply had no knowledge of their duration of AAS use (Jabari et al. 2016). Twenty-five papers did not report duration of AAS use.

Thirteen studies in United Arab Emirates, Saudi Arabia, Kuwait, Sudan and Iran did not report on the reasons for AAS use (Al-Falasi et al. 2008; Alharbi et al. 2019; Allafi et al. 2019; Al Nozha and Elshatarat 2017; Alsaeed and Alabkal 2015; Angoorani and Halabchi 2015; Althobiti et al. 2018; Bahri et al. 2017; Bordbar et al. 2014; Jalilian et al. 2011; Kargarfard et al. 2015; Khidir and Mahmoud 2018; Razavi et al. 2014). Reasons for use of AAS were largely stated as being to improve image, appearance, and overall physique; to increase muscle mass and improve strength and power; achieve

‘attractiveness’; to improve athletic performance; to increase chances of winning body-building competitions; to increase self-confidence and social recognition; and due to advice or recommendation from friends, trainers, and physicians. Other less predominant reasons for use were to increase sex drive, weight gain, fat burning, aid recovery, unspecified medical reasons, and to enhance energy.

The adverse effects of AAS use were not investigated by all studies, with twenty-four papers not reporting on these effects. Self-reported effects by the remaining studies in Kuwait, Bahrain, Saudi Arabia, Iran, and Jordan were aggression, depression, sexual problems, increased appetite, acne, hair loss, gynecomastia, mood changes, fluid retention, headaches, increased hair growth, cardiovascular problems, psychiatric issues, and hepatic and renal damage (Allafi et al. 2019; Alsamani et al. 2017; Althobiti et al. 2018; Bahri et al. 2017; Haerinejad et al. 2016; Hussain et al. 2018; Razavi et al. 2014; Tahtamouni et al. 2008; Uddin et al. 2019; Wazaify et al. 2014). The study by Habeeb et al. (2012) stated that most AAS users reported the use of only dietary supplements initially, but on recommendation of others, initiated the use of AAS to improve performance.

### Knowledge and Understanding of the AAS Concept and Adverse Effects

Studies included in this review reported on user’s knowledge of the AAS ‘concept’ (i.e. their understanding of and expected outcomes of AAS use). Thirteen studies in Kuwait, Iran, Iraq, and Jordan did not examine user’s knowledge and understanding of either AAS concept or adverse effects (Allafi et al. 2019; Allahverdipour et al. 2012; Angoorani and Halabchi 2015; Asr et al. 2018; Boos et al. 2010; Fijan et al. 2018; Habeeb et al. 2012; Hussain et al. 2018; Jalilian et al. 2011; Khullar et al. 2016; Sepehri et al. 2009; Sobhanian et al. 2013; Tahtamouni et al. 2008). It was noted that most participants in these Eastern Mediterranean countries were aware of the anabolic effects of AAS such as increased muscle mass, bodybuilding effects, increased in body weight, and increased muscle strength (Al Bishi and Afify 2017; Al-Falasi et al. 2008; Mohammad 2014). In relation to adverse effects, several papers in Saudi Arabia, United Arab Emirates, Kuwait, and Iran reported an inadequate level of self-reported knowledge overall amongst participants (Al Bishi and Afify 2017; Al-Falasi et al. 2008; Alharbi et al. 2019; Alsaeed and Alabkal 2015; Althobiti et al. 2018; Bahri et al. 2017; Jabari et al. 2016; Khidir and Mahmoud 2018; Mohammad 2014; Rezaei 2017; Uddin et al. 2019; Wazaify et al. 2014; Zafar et al. 2018). Less than half of the participants of the study by Al-Falasi et al. (2008) in the United Arab Emirates had any knowledge of either physical or psychological adverse effects. A high number of participants of the study by Alharbi et al. (2019) in Saudi Arabia answered ‘I don’t know’ when also asked about their awareness of these adverse effects. Haerinejad et al. (2016) reported that the majority of participants had no knowledge of adverse effects prior to use. One study reported that although users ( $n = 16$ ) had knowledge of adverse effects, they continued to use AAS (Kargarfard et al. 2015).

One study reported that overall, it was believed that the benefits of ASS on muscle growth outweighed its adverse harmful effects (Alsaeed and Alabkal 2015). Bordbar et al.’s (2014) study in Iran found that a small number of participants believed that athletes should be allowed to use AAS for athletic performance. Jabari et al. (2016) in Saudi Arabia found that 77% of participants who self-declared knowledge of the adverse effects of AAS would still recommend them to friends. Hitti et al. (2014) noted that users of AAS were more likely to consume alcohol daily than non-AAS users.

## Discussion

We present here the first known attempt to map and describe extant literature on the use of AAS in the Eastern Mediterranean, an emergent phenomenon in the region, and one which we speculate is at early stages of diffusion. Countries where publications were located include Saudi Arabia, United Arab Emirates, Kuwait, Iran, Iraq, Lebanon, Jordan, Bahrain, Afghanistan, Pakistan, and Sudan. Whilst we adhere to the robust Arksey and O Malley protocol for scoping review, we recognise that this review is compromised due to the following limitations. Firstly, only empirical studies were included in the search and investigative journalist reports were not included thus limiting the scope. Secondly, some studies were undertaken in the same country, whereby we do not know if individuals participated in more than one survey, creating a potential overlap, and over estimation of numbers of AAS users. Thirdly, it is unclear as to whether participants were citizens of these countries or whether they were foreigners from other more Westernised cultures. Western influences potentially impact on a country's body ideals, perceptions of masculinity, popularity of exercise and experimentation, and use of enhancement drugs. Religion or faith of the participants was not asked; therefore, we cannot assume that participants are of the Islamic faith. Lastly, some studies did not provide extensive detail on all countries participating in their surveys. Hence, this scoping review should be viewed with caution as it cannot provide an accurate contemporary interpretation of AAS use in the Eastern Mediterranean region. It does however give us insight into the phenomenon at early stages of diffusion with regard to rationales for use, knowledge around use, regimes, locations of use, and sourcing routes.

The use of AAS for performance and image enhancement is a growing concern in these countries; however, knowledge, understanding, and awareness of health harms related to AAS appear to be varied and somewhat limited. Most studies in this review reported AAS users as single and in fulltime employment, highlighting high rates of employment, similar to studies in the UK (Baker et al. 2008; Begley et al. 2017; Greenway and Price 2018), Australia (Jacka et al. 2017), and the USA (Pope et al. 2014a, 2014b). Educational status of AAS current and former users in the Middle East was highest in the 'higher education' range which corroborates research in Australia (Cohen et al. 2007) and the USA (Westerman et al. 2016). Duration of the use of AAS was underreported overall; the maximum length of use reported was 5 years, indicating that the use of AAS amongst some gym populations in the Middle East is clearly established. However, when compared with studies in the UK (Baker et al. 2008; Begley et al. 2017; Greenway and Price 2018), Australia (Jacka et al. 2017), and the USA (Pope et al. 2014a, 2014b), it is evident that this phenomenon is at an early stage of diffusion. This has implications for design of culturally appropriate health-related interventions underpinned by harm reduction and cessation supports in the Eastern Mediterranean. We underscore implications for normalisation of this form of enhancement drug use amongst athletes and gym goers (Mulrooney et al. 2019), with this review providing a key starting point for interventions prior to normalisation of use. There is growing evidence of the possibility of deleterious effects of long-term AAS use on the health of a user's brain (Bjornebekk et al. 2017) and cognitive defects in long-term high dose users (Kanayama et al. 2013).

Research has indicated that factors contributing to decisions to use AAS include beliefs and personal traits (Bates et al. 2018). Building muscle and enhancing physique and training aspects were the primary reasons for gymnasium attendance amongst individuals reporting AAS use in the Eastern Mediterranean. Some less predominant reasons for AAS use centred on desire to increase sex drive, weight gain, fat burning, help improve an injury, medical

reasons, and for more energy. Literature shows that AAS are used for the improvement of physique, increased muscle mass, strength enhancement, and athletic performance enhancement (Begley et al. 2017; Brennan et al. 2016; Ip et al. 2011; Ip et al. 2015; Zahnow et al. 2018). Masculinity is a social construct, as is femininity, and is associated with specific values and cultural contexts (Darwish, 2009). The review suggests that AAS use is overwhelmingly male indicating the presence of this masculine culture, with only a small number of studies reporting female use. This largely reflects the evidence from established literature outside the Eastern Mediterranean, where female use exists at much lower levels than male use and is characterised by stigma and secrecy (Chandler and McVeigh 2014; Ip et al. 2010; Sagoe et al. 2014a, 2014b) but to a lesser extent than males (Brennan et al. 2016).

We recognise that gender and religiosity are symbiotic in their relationship in that religious symbolism facilitates the male ego (Aslam 2012). In other countries, men have a higher prevalence of AAS use than females for example in the USA (Kashkin and Kleber 1989; Tokish et al. 2004; Yesalis 2001), UK (Begley et al. 2017), Poland (Rachoń et al. 2006), and Sweden (Lindqvist et al. 2013), and as such, these findings reflect gender differences in use found in other countries. Islamic faith however prohibits intoxication from alcohol and the use of substances or behaviours that induce addiction such as illicit drugs or gambling (Crabtree et al. 2017; Salaymeh 2015). As mentioned earlier, we do not have participant profile in terms of their citizenship or religiosity. Van Hout and Kean (2015) reported that male Muslim users of AAS and other IPEDs in the UK felt these substances led them to be in control of and promoted their perceptions of their physical and spiritual health, and were not harmful, thus circumventing religious parameters. In addition, we recognise that use of AAS in Islamic faith is discouraged and the legality of AAS is unclear in some Eastern Mediterranean countries where regulatory controls are complex and varied. Of interest is that one study, namely, Angoorani and Halabchi (2015) observed a 25% prevalence of AAS use in their all-female study. This is perhaps indicative of the lower proportion of females attending mainstream gyms (and commonly not attending male gyms) in the included studies (Donnelly et al. 2018).

Users of AAS had some knowledge of the anabolic effects of AAS and the overall AAS 'concept' such as increased muscle mass, bodybuilding effects, and increased power and muscle strength. There was however a concerning and inadequate level of knowledge around adverse effects and health problems (Al Bishi and Afify 2017; Al-Falasi et al. 2008; Alharbi et al. 2019; Alsaeed and Alabkal 2015; Bahri et al. 2017; Jabari et al. 2016; Rezaei 2017). Aggression is a reported adverse psychological effect of AAS use (Bahrke et al. 1996; Bahrke et al. 1990; Pope et al. 2000). Lack of knowledge on such adverse effects is not uncommon and has also been reported in studies in Australia (Yager and O'Dea 2014), Sweden (Nilsson et al. 2005), and the USA (Hoffman et al. 2008). Worldwide, enhanced levels of awareness and knowledge are warranted to support choices to use safely (Nilsson et al. 2005). Of those that included ROA in their surveys, injecting was reported as the predominant route of administration. This may indicate presence of only a small cohort of oral AAS users (similar to recent research by van de Ven et al. (2019)). Blood-borne virus (BBV) transmission associated with any form of injecting drug use is a major public health concern (Heame et al. 2016; Hope et al. 2013; Van Hout 2014). Of note was that questions relating to sharing of injecting equipment or knowledge and awareness of blood-borne virus (BBV) transmission were not asked in the included records. Some records did however refer to the injection of the user by gym trainers; however, harms that may result from this practice were also not investigated further. Of note is the limited reference to support from healthcare professionals to this community. Clearly, there is a role for health professionals in relation to prevention and harm reduction with the potential for pharmacists to take the leading role.

Lastly, sourcing of AAS was reported in a limited number of studies and highlighted how AAS users are highly influenced by availability in gym settings and by coaches and trainers. Some reported being recommended to use AAS by them (Razavi et al. 2014; Fijan et al. 2018) and also sourcing their AAS from them, which supports similar research elsewhere (Fincoeur et al. 2015; Maycock and Howat 2007; Santos and Coomber 2017), given that AAS and associated drugs are illicitly manufactured and sourced (Begley et al. 2017) via routes such as online marketplaces and online private sellers (Brennan et al. 2016), and with low resource countries increasingly involved in manufacture and as transit routes (Evans-Brown et al. 2009).

## Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

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